MEMORANDUM

TO: Docket No. OAR-2002-0058

FROM: Jim Eddinger, U.S. Environmental Protection Agency, OAQPS (C439-01)

DATE: February, 2004

SUBJECT: Revised MACT Floor Analysis for the Industrial, Commercial, and Institutional Boilers and Process Heaters National Emission Standards for Hazardous Air Pollutants Based on Public Comments

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1.0 INTRODUCTION

This memorandum describes the development of the Maximum Achievable Control Technology (MACT) floor and is a revision of the memorandum previously prepared for the proposed rulemaking for the industrial, commercial, and institutional boilers and process heaters National Emission Standard for Hazardous Air Pollutants (NESHAP). The methodology used to develop the MACT floor, the assumptions used for the analysis, the data sources, and the resulting MACT floor for new and existing sources are presented. The memorandum includes the following sections:

Section 2.0　Background Information

Section 3.0　Data Sources

Section 4.0　Affected Source and Subcategories

Section 5.0　General Methodology for the MACT Floor Analysis

Section 6.0　Determination of Best Performing Controls

Section 7.0　Analysis of Good Combustion Practices

Section 8.0　Determination of MACT Floor Emission Limits

Section 9.0　Analysis for Process Heaters

Section 10.0　Determination of Health-Based Alternative TSM Limit

Section 11.0　References

Appendices

2.0   BACKGROUND INFORMATION

Industrial boilers, commercial and institutional boilers, and process heaters were identified as source categories of HAP under section 112(c) of the Clean Air Act (the Act), to be regulated by a NESHAP under section 112(d) of the Act. Indirect-fired process heaters are similar to boilers in fuel use, emissions, and applicable controls, and, consequently are combined with industrial, commercial and institutional boilers for purposes of developing emission standards. Direct-fired units are covered in other MACT standards or rulemakings pertaining to industrial process operations. For example, lime kilns are covered by the Pulp and Paper NESHAP (40 CFR Part 63, subpart S). The source category also does not include combustion units regulated in other standards, including municipal waste combustion units, industrial/commercial waste incinerators, medical waste incinerators, hazardous waste boilers, or pulp and paper recovery boilers.

The Act specifically requires that fossil fuel-fired steam generating units of more than 25 megawatts that produce electricity for sale (i.e., utility boilers) be reviewed separately by EPA. Consequently, fossil fuel-fired utility boilers greater than 25 megawatts are not examined in this source category, but fossil fuel-fired units less than 25 megawatts and all nonfossil fuel-fired utility boilers are included in this source category.   Emissions from combustion units with waste heat boilers are also not included in the source category. Emissions from any commercial or industrial solid waste incinerator (CISWI) or other incinerator unit that has a waste heat boiler will be covered by regulations promulgated under section 129 of the CAA.

Many industrial facilities have office buildings located onsite which use hot water heaters. Such hot water heaters, by their design and operation, could be considered boilers. However, since hot water heaters generally are small and use natural gas as fuel, their emissions are negligible compared to the emissions from the industrial operations that make such facilities major sources, and compared to boilers that are used for industrial, commercial, or institutional purposes. Moreover, such hot water heaters are more appropriately described as residential-type boilers, not industrial, commercial or institutional boilers.   Therefore, residential type hot water heaters are not included in this source category.

Section 112(d) of the Act directs EPA to develop standards that require the maximum degree of reduction in emissions of HAP that is achievable, which are commonly referred to as MACT standards. For existing major sources, the Act requires MACT to be no less stringent than the average emission limitation achieved by the best-performing 12 percent of existing sources among the data available to the Administrator. For new major sources, the Act requires MACT to be no less stringent than the emission control that is achieved in practice by the best-controlled similar source. These minimum stringency levels are often referred to as the "MACT floor."

The term "average", as it pertains to MACT floor determinations for existing sources, described in section 112(d)(3) of the Act, is not defined in the statute. In a Federal Register notice published on June 6, 1994 (59 FR 29196), the EPA announced its conclusion that Congress intended "average" as used in section 112(d)(3) to mean a measure of mean, median, mode, or some other measure of central tendency. The EPA concluded that it retains substantial discretion within the statutory framework to set MACT floors at appropriate levels, and that it construes the word "average" (as used in section 112(d)(3)) to authorize the EPA to use any reasonable method, in a particular factual context, of determining the central tendency of a data set.

3.0   DATA SOURCES

Various sources of data were used in the MACT floor analysis for boilers and process heaters. The boiler and process heater population database was used to characterize the number and types of existing units, the types of fuels burned, the capacity of the units, the types of existing add-on control technologies, and the locations of these units. This database includes information on approximately 42,000 boilers and 15,000 process heaters. The development of this database is discussed in the memorandum "*Development of the Population Database for the Industrial, Commercial, and Institutional Boiler and Process Heater National Emission Standard for Hazardous Air Pollutants (NESHAP)*".[1]

The boiler emissions test database was used in correlation with the population database to characterize the type and magnitude of hazardous air pollutants (HAP) that are emitted from various types of combustion units that burn different fuel combinations and have different levels and types of existing add-on control technologies. The development of the emissions test

database is discussed in detail in the memorandum "*Development of the Emissions Test Database for the Industrial, Commercial, and Institutional Boiler National Emission Standard for Hazardous Air Pollutants (NESHAP)*".[2] In addition, emission data submitted during the public comment period were included in the final analysis, where appropriate.

Other sources of data were reviewed to assess the performance of various types of add-on control devices. The sources reviewed and the conclusions drawn from this review regarding the performance and applicability of add-on control techniques to the combustion units included in this source category are discussed in the memorandum "*Methodology for Estimating Cost and Emissions Impacts for Industrial, Commercial, Institutional Boilers and Process Heaters National Emission Standards for Hazardous Air Pollutants*".[3]

Another data source used during the MACT floor analysis was regulations that pertain to boilers and process heaters from various state air pollution control agencies. Regulations pertaining to these sources were reviewed for all states that had rules that apply to combustion sources.

4.0   AFFECTED SOURCE AND SUBCATEGORIES

4.1   Description of Affected source

This MACT includes the industrial boilers, institutional and commercial boilers, and process heaters source categories. The definition of affected source has been revised based on public comments to be the collection of existing industrial, commercial, or institutional boilers and process heaters located at a major source facility. Process heaters are defined as units in which the combustion gases do not directly come into contact with process gases in the combustion chamber (e.g. indirect fired). Boiler means an enclosed device using controlled flame combustion and having the primary purpose of recovering thermal energy in the form of steam or hot water. Because facilities could have multiple boilers and process heaters on-site that burn different types of fuels and have different levels of add-on controls, the MACT floor is determined by evaluating emissions and feasability of controls separately for particular subcategories of units within the affected source. A major source of HAP emissions is any stationary source or group of stationary sources located within a contiguous area and under common control that emits or has the potential to emit any single HAP at a rate of 10 tons or

more per year or any combination of HAP at a rate of 25 tons or more a year. The affected source does not include those units in Section 2.0 that are excluded from the source category.

A wide variety of pollutants may be emitted from boilers and process heaters, including HAP's, VOC's, and criteria pollutants. The HAP's emitted from boilers and process heaters can be categorized as either inorganic HAP (primarily acid gases such as hydrogen chloride or hydrogen fluoride), organic HAP's (such as benzene or PAH's), and metallic HAP (such as mercury or lead). Due to its health affects and different emission characteristics, mercury is often analyzed separately from non-mercury metallic HAPs. The types and amounts of pollutants emitted from these sources depends greatly on the type of fuel being burned in the combustion device.

4.2   Subcategories

The Act allows source categories to be divided into subcategories when differences between given types of units lead to corresponding differences in the nature of emissions and the technical feasibility of applying emission control techniques. The design, operating, and emissions information that EPA has reviewed indicate the need to subcategorize boilers and process heaters based on the physical state of the fuel burned, i.e., solid, liquid, or gas. Data indicate that there are significant design and operational differences between units that burn solid, liquid and gaseous fuels.

Boiler systems are designed for specific fuel types and will encounter problems if a fuel with characteristics other than those originally specified is fired. While many boilers in the population database are indicated to co-fire liquids or gases with solid fuels, in actuality most of these commonly use fuel oil or natural gas as a startup fuel only. Other co-fired units are specifically designed to fire combinations of solids, liquids, and gases. Changes to the fuel type (solid, liquid, or gas) would require extensive changes to the fuel handling and feeding system (e.g., a stoker using wood as fuel would need to be redesigned to handle fuel oil or gaseous fuel). Additionally, the burners and combustion chamber would need to be redesigned and modified to handle different fuel types and account for increases or decreases in the fuel volume and shape. In some cases, the changes may reduce the capacity and efficiency of the boiler or process heater. An additional effect of these changes would be extensive retrofit costs.

Emissions from boilers and process heaters burning solids, liquids, and gaseous fuels will also differ. Boilers and process heaters emit a number of different types of HAP emissions. In

general, their formation is dependent upon the composition of the fuel. The combustion quality and temperature may also play an important role. The fuel dependent HAP emissions from boilers and process heaters are metals, including mercury, and acid gases. These fuel dependent HAP emissions generally can be controlled by either changing the fuel property before combustion or by removing the HAP from the flue gas after combustion. Organic HAP, on the other hand, are formed from incomplete combustion and are much less influenced by the characteristics of the fuel being burned. The degree of combustion may be greatly influenced by three general factors: time, turbulence, and temperature. These factors are a function of the design of the boiler or process heater which is dependent in part on the type of fuel being burned. The different emission characteristics will affect the type of air pollution controls that may be used. Accordingly, the source category was divided into three subcategories to consider these differences: solid fuel-fired units, liquid fuel-fired units, and gaseous fuel-fired units. The solid subcategory includes units that burn any amount of solid fuel. The gaseous subcategory includes units that only burn gaseous fuel, except during periods of natural gas curtailment. The liquid subcategory includes the remaining units.

Another factor that affects emissions from boilers and process heaters is the combustor design. The combustor design influences the completeness of the combustion process and the formation of organic compounds. Boilers with capacities less than 10 MMBtu/hr use combustor designs (e.g., firetube or cast-iron) which are not common in units above 10 MMBtu/hr. Large boilers generally are field-erected using watertube combustor design with capacities above 10 MMBtu/hr. The vast majority of these small units use natural gas as fuel. Additionally, most existing State and Federal regulations for boilers and process heaters do not regulate units with a heat input capacity of less than 10 MMBtu/hr, due to their low emissions. Accordingly, the three subcategories were further divided into large units (watertube boilers and process heaters > 10 MMBtu/hr capacity) and small units (all firetube boilers and process heaters $\leq$ 10 MMBtu/hr capacity) to differentiate the combustor designs typically found in these size ranges.

A third subcategory classification was also considered to distinguish units that are operated infrequently, such as back-up or emergency units. Back-up or emergency units only operate if another boiler that is the regular source of energy or steam is not operating (for example due to a shutdown for maintenance and repair). Peaking units operate only during peak energy use periods, typically in the summer months. The boiler database indicates that these

infrequently operated units typically operate 10 percent of the year or less. These limited use boilers, when called upon to operate, must respond without failure and without lengthy periods of startup. This subcategorization was made because the limited use units, those with capacity utilizations less than 10 percent, have a specialized use and operation that are different from typical industrial, commercial, and institutional units.

Thus, a total of nine subcategories were developed for this source category: (1) large solid fuel-fired boilers and process heaters, (2) large liquid fuel-fired boilers and process heaters, (3) large gaseous fuel-fired boilers and process heaters, (4) limited use solid fuel-fired boilers and process heaters, (5) limited use liquid fuel-fired boilers and process heaters, (6) limited use gaseous fuel-fired boilers and process heaters, (7) small solid fuel-fired boilers and process heaters, (8) small liquid fuel-fired boilers and process heaters, and (9) small gaseous fuel-fired boilers and process heaters. Because these subcategories were defined based on fundamental differences in the types of emissions, all MACT floor analyses were done separately for each individual subcategory.

5.0   GENERAL METHODOLOGY FOR MACT FLOOR ANALYSIS

Many approaches were considered for determining the MACT floor including use of emissions data only, use of state regulations and permits, review of possible process changes, and review of add-on controls. The limitations of the data available resulted in some of these approaches not being appropriate options for developing the MACT floor. Consequently, the most appropriate approach for determining MACT floors for boilers and process heaters is to look at the control options used by the units within each subcategory in order to identify the best performing units. The methodology used consisted of using information on controls from the population database, emissions from the emissions database and public comments, and State regulations.   The consideration of the approaches that were not used is discussed below. The consideration of process changes or work practices is discussed in Section 7.0.

The first step in the methodology was to identify the control technologies used by the best-controlled sources in each subcategory for controlling four classes of pollutants: non-mercury metallic HAP, mercury, inorganic HAP, and organic HAP. The population database was used to determine the existing numbers and types of boilers and process heaters with the best technologies used to control these HAP emissions. The database contains specific

information on the types of control devices that are present for most of the boilers and process heaters. However, it does not include any unit-specific data on the control device design or the actual emissions from the individual combustion units in the population database. The emission limits for each class of pollutant associated with the best control technologies were then determined using information in the emissions database and any additional emission data obtained during the public comment period. Limits were identified in units of pound of pollutant per million Btu (lb/MMBtu) of heat input to be consistent with the format of the New Source Performance Standard (NSPS) for industrial boilers as well as other existing boiler regulations.

5.1 Consideration of Emission Test Data Only

Under one approach, the MACT floor for a category of sources could be calculated by ranking the emission test results from units within the category from lowest to highest, and then taking the numerical average of the test results from the best performing (lowest emitting) 12 percent of sources.

However, review of the available HAP emission test data indicated several problems with using this MACT floor approach to establish emission limits for boilers and process heaters. First, the emissions database is very limited for HAP emissions from industrial boilers. Prior to proposal and during the Industrial Combustion Coordinated Rulemaking (ICCR) process, EPA conducted a thorough search for HAP emission test reports. This search was supported by industry, trade groups, and States. For criteria pollutants, such as PM, substantial emission information was available and gathered. For HAP, this was not the case. Industrial boilers have not generally been required to test for HAP emissions. In the proposed rule, we requested commenters to provide additional emissions information. However, only one source provided any additional emissions data (mercury test results from three additional coal-fired industrial boilers). The main problem with using only the HAP emissions data is that, based on the test data alone, uncontrolled units (or units with low efficiency add-on controls) were frequently identified as being among the best performing 12 percent of sources in a subcategory, while many units with high efficiency controls were not. However, these uncontrolled or poorly controlled units are not truly among the best controlled units in the category. Rather, the emissions from these units are relatively low because of particular characteristics of the fuel that they burn, that can not reasonably be replicated by other units in the category or subcategory.

This kind of variability in emission rates is expected given the variety of fuel types included within each subcategory of boilers and process heaters.

A review of fuel analyses indicate that the concentration of HAP (metals, HCl, mercury) can vary greatly, not only between fuel types, but also within each fuel type. Some fuels even have pollutant concentration levels below the detection limit of the applicable analytical test method. Therefore, a unit without any add-on controls, but burning a fuel containing lower amounts of HAP, can have emission levels that are lower than the emissions from a unit with the best available add-on controls. If only the available HAP emissions data are used, the resulting MACT floor levels would, in most cases, be unachievable for many, if not most, existing units, even those that employ the most effective available emission control technology. For example, an uncontrolled boiler burning wood may have lower emissions of mercury than a well controlled boiler burning coal. This would result in some coal burning boilers never being able to achieve the mercury HAP level of the wood-fired unit, no matter what add-on controls are used. In this instance, establishing a MACT standard based on emission data alone would force the coal units to switch to different fuels to achieve the MACT limits.

Another problem with using only emissions data is that there is no HAP emissions information for some subcategories. This is consistent with the fact that units in these source categories have not historically been required to test for HAP emissions.

5.2   Consideration of State Regulations and Permits

HAP emission limits contained in State regulations and permits were also reviewed as a surrogate for actual emission data in order to identify the emissions levels from the best performing units in the category for purposes of establishing MACT standards. However, no State regulations or State permits were found which specifically limit HAP emissions from these sources.

5.3   Consideration of Fuel Switching

Fuel switching was examined as an appropriate control option for sources in each subcategory. The feasibility of both fuel switching to other fuels used in the subcategory and to fuels from other subcategories were considered. This consideration included determining whether switching fuels would achieve lower HAP emissions. A second consideration was whether fuel switching could be technically achieved by boilers and process heaters in the

subcategory considering the existing design of boilers and process heaters. The availability of various types of fuel was also reviewed.

After considering these factors, fuel switching was determined to not be an appropriate control technology for purposes of determining the MACT floor level of control for any subcategory. This decision was based on the overall effect of fuel switching on HAP emissions, technical and design considerations discussed earlier, and concerns about fuel availability.

Data available in the emissions database indicates that while fuel switching from solid fuels to gaseous or liquid fuels would decrease PM and some metals emissions, emissions of some organic HAP would increase, resulting in uncertain benefits. This determination is discussed in the memorandum "*Development of Fuel Switching Costs and Emission Reductions for Industrial/Commercial/Institutional Boilers and Process Heaters National Emission Standards for Hazardous Air Pollutants*".[4] In order to adopt such a strategy, the relative risk associated which each HAP emitted would need to be analyzed, as well as whether requiring the control in question would result in overall lower risk.

A similar determination was made when considering fuel switching to cleaner fuels within a subcategory. For example, the term "clean coal" refers to coal that is lower in sulfur content and not necessarily lower in HAP content. Data gathered also indicates that within specific coal types HAP content can vary significantly. Switching to a low sulfur coal may actually increase emissions of some HAP. Therefore, fuel switching to a low sulfur coal as part of the MACT standards for boilers and process heaters could not be included in the analysis. Fuel switching from coal to biomass would result in similar impacts on HAP emissions. While this would reduce metallic HAP emissions, it would likely increase emissions of organics based on information in the emissions database.

Another factor considered was the availability of alternative fuel types. Natural gas pipelines are not available in all regions of the U.S., and natural gas is simply not available as a fuel for many industrial, commercial, and institutional boilers and process heaters. Moreover, even where pipelines provide access to natural gas, supplies of natural gas may not be adequate. For example, it is common practice in cities during winter months (or periods of peak demand) to prioritize natural gas usage for residential areas before industrial usage. Consequently, even where pipelines exist some units would not be able to run at normal or full capacity during these

times if shortages were to occur. Therefore, under any circumstances, there would be some units that could not comply with a requirement to switch to natural gas.

Similar problems for fuel switching to biomass could arise. Existing sources burning biomass generally are combusting a recovered material from the manufacturing or agriculture process. Industrial, commercial, and institutional facilities that are not associated with the wood products industry or agriculture may not have access to a sufficient supply of biomass materials to replace their fossil fuel.

There is also a significant concern that switching fuels would be infeasible for sources designed and operated to burn specific fuel types. Changes in the type of fuel burned by a boiler or process heater (solid, liquid, or gas) may require extensive changes to the fuel handling and feeding system (e.g., a stoker using wood as fuel would need to be redesigned to handle fuel oil or gaseous fuel). Additionally, burners and combustion chamber designs are generally not capable of handling different fuel types, and generally cannot accommodate increases or decreases in the fuel volume and shape. Design changes to allow different fuel use, in some cases, may reduce the capacity and efficiency of the boiler or process heater. Reduced efficiency may result in less complete combustion and, thus, an increase in organic HAP emissions.

6.0 DETERMINATION OF THE MACT FLOOR BASED ON CONTROL TECHNIQUES

6.1 Identification of Typical Add-on Control Devices in Population Database

The initial step for the MACT floor analysis based on control technologies was to identify the typical types of add-on control technologies used on existing boilers and process heaters in the population database. The population database sometimes includes specific descriptions regarding the types of add-on devices that are on the combustion units. These specific control devices in the population database were grouped into more general control device categories in order to simplify the analysis. For instance, high temperature and low temperature fabric filters were grouped into a general fabric filter category. Also, control techniques listed in the population database that were assumed to have no effect on HAP emissions, such as low NOx burners or fuel air recirculation, were not considered in these control device groupings. Because many of the specific control devices listed in the population database were assumed to achieve similar control efficiencies, this grouping process did not

result in a less accurate MACT floor analysis. The control device groupings are presented in Appendix A-1.

6.2   **Control Technology Assessments**

Once the types of existing add-on control devices were determined and grouped into more general control categories, the technologies were ranked in terms of their relative performance. The rankings for each control device category were based on the typical control efficiency each was expected to achieve. The memorandum "*Methodology for Estimating Cost and Emissions Impacts for Industrial, Commercial, Institutional Boilers and Process Heaters National Emission Standards for Hazardous Air Pollutants*"[3] discusses typical efficiencies assigned to the control devices. The rankings were assigned as follows: ranking of "1" means the control device can achieve greater than 99% control efficiency, ranking of "2" means greater than 98% control efficiency, ranking of "3" means greater than 90% control efficiency, ranking of "4" means greater than 75% control efficiency, ranking of "5" means greater than 50% control efficiency, ranking of "6" means greater than 30% control efficiency, ranking of "7" means less than 30% control efficiency, and a ranking of "8" means that the control device achieves no control. The control devices were ranked in this manner by relative control efficiencies individually for each of the pollutant categories (inorganic HAP, organic HAP, non-mercury metallic HAP, and mercury) because the most effective control devices for each of these pollutant categories are sometimes different. For example, ESP's are effective in controlling metallic HAP emissions, but are ineffective in controlling organic HAP or inorganic HAP emissions.

6.3   **Determination of the Best-performing Sources based on Control Technologies**

The boilers and process heaters in the population database in each subcategory were ranked based on their controls in order of decreasing control effectiveness for each of the pollutant categories. That is, the boilers and process heaters in each subcategory were ranked separately for each of these pollutant categories according to the units that have the best-performing controls for each specific type of pollutant. The best-performing 12 percent of sources for existing sources or best-performing "similar source" for new sources was identified for each of these pollutant categories separately.

Once the control device categories were ranked along with the number of units in each category, the percentage of units with the best-performing control devices was determined for each pollutant category. This calculation was done by dividing the number of units with a ranked control device by the total number of units. However, the percentage of units with each type of control device was based only on the population of units for which control device information was available. The population database, on which this analysis is based, does not have control information available for every boiler and process heater. Often the control device database field specified a particular control device or combination of control devices on a unit, sometimes the field specified that a unit had no control devices, but sometimes the database field was blank. These units with blank control information data fields were excluded from the MACT floor analysis because using them would have required that broad assumptions be made about the types of controls that might be on these units. Therefore, the MACT floor analysis is actually done using a subset of the population database that is assumed to be representative of the entire population. The summary tables in Appendix A show the number of units with "no information" for each of the subcategories.

For new sources, the best-performing control devices in each subcategory are those ranked with the highest removal efficiency for each pollutant. For existing sources, the best-performing 12 percent of sources needed to be identified. Once the control device categories were ranked from best-performing to worst-performing for each subcategory and pollutant category by the control rankings, and the percentages of units using each control were calculated, the cumulative percentage of units represented was reviewed to determine the best-performing 12 percent of units. The median unit in the best-performing 12 percent of units (i.e., the boiler or process heater unit representing the 94th percentile) was used to represent the technology associated with the MACT floor level of control for each subcategory. Because the control device rankings were done using a scale from 1 to 8 based on control efficiencies, different control device categories might have the same efficiency ranking for a pollutant category. Because there is no distinction in performance between control devices with the same efficiency ranking, if the six percent level occurred in the middle of a control device category ranking, then all sources that had existing controls ranked at that level or better were included in the group of units that were considered to be the best-performing 12 percent of sources.

The summary tables in Appendix A indicate which units and control device categories are included in the best-performing 12 percent of sources for each subcategory and pollutant category. Table 6-1 summarizes the results of the MACT floor control technologies analysis. A discussion of the results for each subcategory is presented in the following sections.

6.4   Best Performing Control Technologies for Existing Sources

6.4.1   Existing Solid Fuel Boilers and Process Heaters

Large Units - Heat Inputs Greater than 10 MMBtu/hr. The most effective control technologies identified for removing non-mercury metallic HAP are fabric filters. About 14 percent of solid fuel-fired boilers and process heater use fabric filters. The most effective control technologies identified for removing inorganic HAP that are acid gases, such as HCl, are wet scrubbers and packed bed scrubbers. These technologies are used by about 13 percent of the boilers and process heaters in the large solid fuel subcategory. About 12 percent of solid fuel-fired boilers and process heaters use wet or dry scrubbers, and approximately 1 percent use packed bed scrubbers. Based on test information on utility boilers, fabric filters are determined to be the most effective technology for controlling mercury emissions.[3] As discussed previously, approximately 14 percent of sources in the subcategory use fabric filters. No add-on control technologies that would reduce organic HAP emissions were identified as being used.

Therefore, the combination of fabric filter and wet scrubber control technologies forms the basis for the MACT floor level of control for existing large solid fuel boilers or process heaters. This analysis is shown in Appendix A-2.

Small Units - Heat Inputs Less than or Equal to 10 MMBtu/hr. For each pollutant group (non-mercury metallic HAP, mercury, inorganic HAP/HCl, and organic HAP), less than 6 percent of the units in this subcategory used control techniques that limit emissions. This analysis is shown in Appendix A-3.

Limited Use Units - Capacity Utilizations Less than or Equal to 10 Percent. The most effective control technologies identified for removing non-mercury metallic HAP are ESP and fabric filters. Less than 2 percent of limited use solid fuel-fired boilers and process heater use fabric filters, and 14 percent use ESP.

Similar control technology analyses were done for the boilers and process heaters in this subcategory for inorganic HAP, organic HAP and mercury. For each of these pollutant groups, less than 6 percent of the units in this subcategory used control techniques that limit emissions.

Consequently, ESP and fabric filters, which achieve non-mercury metallic HAP control, form the basis for the MACT floor level of control for existing solid fuel boilers and process heaters in this subcategory. This analysis is shown in Appendix A-4.

6.4.2   Existing Liquid Fuel Boilers and Process Heaters

Less than 6 percent of the units in each of the liquid subcategories used control techniques that would reduce non-mercury metallic HAP, mercury, organic HAP, or acid gases, (such as HCl). This analysis is shown in Appendices A-5 through A-7.

6.4.3   Existing Gaseous Fuel Boilers and Process Heaters

No existing units in the gaseous fuel-fired subcategories were using control technologies that achieve consistently lower emission rates than uncontrolled sources for any of the pollutant groups of interest. This analysis is shown in Appendices A-8 through A-10.

6.5   Best Performing Control Technologies for New Sources

6.5.1   New Solid Fuel-fired Units

Large Units - Heat Inputs Greater than 10 MMBtu/hr. The most effective control technology identified for removing non-mercury metallic HAP are fabric filters. The most effective control technologies identified for removing inorganic HAP including acid gases, such as HCl, are wet or dry scrubbers. Wet scrubbers is a generic term that is most often used to describe venturi scrubbers, but can include packed bed scrubbers, impingement scrubbers, etc. One percent of boilers and process heaters in this subcategory reported using a packed bed scrubber. Emission test data from other industries suggests that packed bed scrubbers achieve consistently lower emission levels than other types of wet scrubbers.

For mercury control, one technology, carbon injection, that has demonstrated mercury reductions in other source categories (i.e., municipal waste combustors), was identified as being used at one existing industrial boiler facility. However, test data on this carbon injection system indicated that this unit was not achieving mercury emissions reductions. Therefore, carbon injection was not considered to be a MACT floor control technology for industrial, commercial, and institutional boilers and process heaters. Data from electric utility boilers indicate that fabric filters are the most effective technology for controlling mercury emissions. No add-on control technologies that would reduce organic HAP emissions were identified as being used on units in this subcategory.

The combination of a fabric filter and a packed bed scrubber forms the technology basis for the MACT floor level of control for new solid fuel boilers and process heaters in this subcategory. See Appendix A-2.

Small Units - Heat Inputs Less than or Equal to 10 MMBtu/hr. The most effective control technology identified for removing nonmercury metallic HAP are fabric filters. The most effective control technology identified for units in this subcategory for removing acid gases, such as HCl, are wet scrubbers. The most effective control technology identified for removing mercury is fabric filters. No add-on control technologies that would reduce organic HAP emissions were identified as being used on units in this subcategory.

The combination of a fabric filter and a wet scrubber forms the technology basis for the MACT floor level of control for new solid fuel boilers and process heaters in this subcategory. See Appendix A-3.

Limited Use Units - Capacity Utilizations Less than or Equal to 10 Percent. The most effective control technology identified for removing non-mercury metallic HAP and mercury are fabric filters. The most effective control technology identified for units in this subcategory for removing acid gases, such as HCl, are wet scrubbers. No add-on control technologies that would reduce organic HAP emissions were identified as being used on units in this subcategory.

The combination of a fabric filter and a wet scrubber forms the technology basis for the MACT floor level of control for new solid fuel boilers and process heaters in this subcategory. See Appendix A-4.

6.5.2 New Liquid Fuel-fired Units

Large Units - Heat Inputs Greater than 10 MMBtu/hr. The most effective control technology identified for removing non-mercury metallic HAP are ESPs. The most effective control technology identified for removing inorganic HAP that are acid gases, such as HCl, are packed bed scrubbers. Information in the emissions database or from other source categories does not show that control technologies, such as fabric filters, ESP, or wet scrubbers, achieve reductions in mercury emissions from liquid fuel-fired industrial, commercial, and institutional boilers and process heaters. No add-on control technology being used in the existing population of boilers and process heaters in these subcategories that consistently achieved lower emission rates than uncontrolled levels, such that a best controlled similar source for organic HAP could be identified.

The combination of an ESP and a packed bed scrubber forms the technology basis for the MACT floor level of control for new liquid fuel boilers and process heaters in this subcategory. See Appendix A-5.

Small Units - Heat Inputs Less than or Equal to 10 MMBtu/hr. The most effective control technology identified for removing non-mercury metallic HAP used by units in this subcategory are ESPs. The most effective control technology identified for units in this subcategory for removing acid gases, such as HCl, are wet scrubbers.

Information in the emissions database or from other source categories does not show that control technologies, such as fabric filters, ESP, or wet scrubbers, achieve reductions in mercury emissions from liquid fuel-fired industrial, commercial, and institutional boilers and process heaters. No add-on control technology being used in the existing population of boilers and process heaters that consistently achieved lower emission rates than uncontrolled levels, such that a best controlled similar source for mercury or organic HAP could be identified.

The combination of a fabric filter and a wet scrubber forms the technology basis for the MACT floor level of control for new liquid fuel boilers and process heaters in this subcategory. See Appendix A-6.

Limited Use Units - Capacity Utilizations Less than or Equal to 10 Percent. The most effective control technology identified for removing non-mercury metallic HAP used by units in this subcategory are ESPs. The most effective control technology identified for units in this subcategory for removing acid gases, such as HCl, are wet scrubbers.

Information in the emissions database or from other source categories does not show that other control technologies, such as fabric filters, ESP, or wet scrubbers, achieve reductions in mercury emissions from liquid fuel-fired industrial, commercial, and institutional boilers and process heaters. No add-on control technology being used in the existing population of boilers and process heaters that consistently achieved lower emission rates than uncontrolled levels, such that a best controlled similar source for mercury or organic HAP could be identified. See Appendix A-7.

Gaseous Fuel Subcategories. No existing units were using control technologies that achieve consistently lower emission rates than uncontrolled sources for any of the pollutant groups of interest. See Appendices A-8 through A-10.

7.0   ANALYSIS OF WORK PRACTICES AND PROCESS CHANGES

Upon review of the emissions test data, it was determined that no control technology consistently achieved organic HAP emission levels any lower than those from uncontrolled boilers. Therefore, there is no achievable MACT floor emissions level that can be established for the organic HAP pollutant category.

The HAP emissions from boilers and process heaters are primarily dependent upon the composition of the fuel. Fuel dependent HAP are metals, including mercury, and acid gases. Fuel dependent HAP are typically controlled by removing them from the flue gas after combustion. Therefore, they are not affected by the operation of the boiler or process heater. Consequently, process changes would be ineffective in reducing these fuel-related HAP emissions.

Organic HAP can be formed from incomplete combustion of the fuel. Combustion is defined as the rapid chemical combination of oxygen with the combustible elements of a fuel. The objective of good combustion is to release all the energy in the fuel while minimizing losses from combustion imperfections and excess air. The combination of the fuel with the oxygen requires temperature (high enough to ignite the fuel constituents), mixing or turbulence (to provide intimate oxygen-fuel contact), and sufficient time (to complete the process), sometimes referred to the three Ts of combustion. Good combustion practice (GCP), in terms of boilers and process heaters, could be defined as the system design and work practices expected to minimize organic HAP emissions. The GCP control strategy could include a number of combustion conditions and work practices which are applied collectively to achieve this goal.

While few sources specifically reported using good combustion practices, boilers and process heaters within each subcategory might use any of a wide variety of different work practices, depending on the characteristics of the individual unit. The lack of information, and lack of a uniform approach to assuring combustion efficiency, is not surprising given the extreme diversity of boilers and process heaters, and given the fact that no applicable Federal standards, and most applicable State standards, do not include work practice requirements for boilers and process heaters. Even those States that do have such requirements do not require the same work practices.

Consequently, any uniform requirements or set of work practices that would meaningfully reflect the use of good combustion practices, or that could be meaningfully implemented across any subcategory of boilers and process heaters could not be identified.

Additionally, few of the GCP's have been documented to reduce organic HAP emissions, and they could not be considered in the MACT analysis. One GCP that may effect organic HAP emissions is maintaining CO emission levels. CO is generally an indicator of incomplete combustion because CO will burn to carbon dioxide if adequate oxygen is available. Controlling CO emissions is a mechanism for ensuring combustion efficiency, and therefore may be viewed as a kind of GCP.[5] As discussed in section 8.0, CO is also considered a surrogate for organic HAP.

To determine if CO monitoring would be the basis of the existing and new source MACT floor for organic HAP emissions control, available information was examined. The population database does not contain information on existing units monitoring CO emissions. State regulations applicable to boilers and process heaters that required CO monitoring to maintain a specific CO limit were then reviewed. Many of the state regulations identified were applicable to units of only certain capacities, heat inputs, or fuel types. The applicability of these state requirements were matched to the units in the population database to determine which units were subject to a particular requirement and which were not. First, the units that were located in states with CO requirements were identified using the state codes in the population database. Then the corresponding unit capacities and fuel types were reviewed to determine if the CO requirement applied. In some cases, the applicability requirements were too specific to be able to identify whether a unit would be subject to the requirement or the population database would not have enough information regarding a specific unit (such as unit capacity) to determine if the requirement would apply. In the cases where the applicability of a requirement could not be determined, the associated units were not included in the MACT floor analysis because too many assumptions would have to be made regarding whether requirements applied. Instead, as with the add-on control technology analysis, the MACT floor analysis based on CO requirements was done using a subset of the population in each subcategory for which the applicability could be determined. This subset was assumed to be representative of the entire subcategory. The results showed that less than 6 percent of the existing units in any subcategory were subject to CO

monitoring requirements or emission limits. Therefore, it did not constitute a MACT floor level of control. This analysis is presented in Appendix B.

For new sources, the analysis of State regulations indicated that at least one of the boilers and process heaters in the large and limited use subcategories for solid fuel, liquid fuel, and gaseous fuel were required to meet a CO emissions limit. The State with the most stringent CO emission limit that applies to all units within a subcategory is California, which requires monitoring and maintaining a CO limit of 400 ppm. Another state, Massachusetts, has a limit of 200 ppm. However, the limit does not necessarily apply to all boilers in a subcategory, (i.e., it would apply to large solid fuel boilers but would not be applicable to wood-fired units or units in lower size ranges). Consequently, the 200 ppm limit would not be appropriate for the entire subcategory. Therefore, the new source MACT floor includes a CO emission limit of 400 ppm to reflect the MACT floor level of control for emissions of organic HAP from the large and limited use solid, liquid, and gaseous subcategories. (The California State regulations reviewed are included in the boiler and process heater docket as items II-I-83 through II-I-86)

8.0   MACT FLOOR EMISSION LIMIT METHODOLOGY

The available emissions data for boilers and process heaters controlled by the best-performing technologies in each subcategory were reviewed to determine the emissions levels associated with the MACT floor control technology. Using the technology-basis for the MACT floor for each subcategory, the corresponding emission limitations were determined for each pollutant category.

An outlet emission rate format was used for the MACT floor analysis because outlet data are available for boilers and process heaters that use the control techniques that provide the greatest reduction in HAP emissions. The individual limits reflect the achievable performance of boilers and process heaters using the appropriate controls for each type of emissions.

The most typical units for the limits are pounds of pollutant emitted per million British thermal units (Btu) of heat input. The mass per heat input units are consistent with other Federal and many State boiler regulations and allows easy comparison between such requirements.

8.1   Surrogates for Pollutant Categories

The MACT floor based on control technology was conducted for each subcategory and for four pollutant categories: non-mercury metallic HAP, mercury, inorganic HAP, and organic

HAP. These categories, which cover all the HAP emitted, include a large number of compounds, making it infeasible to develop emission limits for each one. Consequently, surrogate pollutants were identified to represent the pollutants in each category.

8.1.1 Non-Mercury Metallic HAP

There are many different non-mercury metallic HAP that could be emitted from boilers and process heaters including arsenic, beryllium, cadmium, chromium, lead, manganese, and nickel. Most, if not all, non-mercury metallic HAP emitted from combustion sources will appear on the flue gas fly-ash. Therefore, the same control techniques that would be used to control the fly-ash PM will control non-mercury metallic HAP. Also, all fuels do not emit the same type and amount of metallic HAP but most generally emit PM that includes some amount and combination of metallic HAP. Therefore, the MACT floor emission level associated with the best-performing 12 percent of sources for the non-mercury metallic HAP category was set using particulate matter as a surrogate.

However, there are some sources in the solid fuel-fired categories that burn a fuel containing very little metals, but with sufficient PM emissions to require control. In such cases, PM would not be an appropriate surrogate for metallic HAP. Therefore, an alternative metals emission limit was also developed for solid fuel-fired sources. The metals emission limit is for the sum of emissions of eight selected metals: arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, and selenium. These eight pollutants represent the most common and the largest emitted metallic HAP from boilers and process heaters.

8.1.2 Inorganic HAP

As with non-mercury metallic HAP, there are several pollutants which fall into the inorganic HAP pollutant category including hydrogen chloride and hydrogen fluoride. The emissions test information available to EPA indicate that the primary inorganic HAP emitted from boilers and process heaters are acid gases, with HCl present in the largest amounts. Other inorganic compounds emitted are found in much smaller quantities. Also, control technologies that would reduce HCl would also control other inorganic compounds that are acid gases. Therefore, HCl is considered a good surrogate for inorganic HAP and controlling HCl will result in a corresponding control of other inorganic HAP emissions.

8.1.3 Mercury

A MACT floor emission limit was determined specifically for mercury and not for a surrogate compound. All the mercury emissions data were reviewed to determine the associated emission level that corresponds to the levels from the units determined to be the technology basis of the MACT floor.

8.1.4   Organic HAP

For organic HAP, carbon monoxide (CO) was chosen as a surrogate to represent the variety of organic compounds, including dioxins, emitted from the various fuels burned in boilers and process heaters. CO is a good indicator of incomplete combustion and, thus, the formation of organic HAP emissions. Therefore, using CO as a surrogate for organic HAP is a reasonable approach because minimizing CO emissions will result in minimizing organic HAP emissions.

8.2   Methodology for establishing MACT floor emission levels

After the MACT floor based on control techniques was identified for each subcategory and pollutant group, the emissions database was reviewed to identify all emission tests for the pollutant groups that also had the MACT floor control technology. Then, the emission levels, in units of pound pollutant per MMBtu heat input, were reviewed for each pollutant group surrogate in order to determine an emission level associated with the MACT floor level of control.

First the data and associated emission test reports for all the higher emission points were reviewed to identify any outliers and determine if there was something about the test conditions or control device operation that made it unrepresentative of the MACT floor level of control or the entire subcategory population. Several data points were removed from the analysis because their unrepresentativeness.

The summary tables in Appendix C indicate which test data were used in the calculation of emission limits for each subcategory and pollutant group. Table 8-1 summarizes the results of the MACT floor control technologies analysis. A discussion of the results for each subcategory is presented in following sections.

8.2.1   Existing Source MACT Floor Emission Levels

For existing sources, the calculation of numerical emission limits was a two-step analysis. The first step involved calculating a numerical average of an appropriate subset of the emission test data from units using the same technology, or technologies, as the units in the top

12 percent. Based on the initial ranking, the proportion of the units using a particular technology that were among the top 12 percent of units in the subcategory were identified. Then, a corresponding proportion of the emission test data from units using that type of control technology were reviewed, and an overall average measured performance level was calculated. For example, in the large solid-fuel subcategory, approximately 14 percent of units used the best performing control technology for PM/metallic HAP (baghouses). In order to rank the units using the best technology for which there were emission test data, unit by unit measured performance levels were calculated by averaging the multiple tests from each individual unit (if multiple tests were available). The best 12/14 of the units for which we generated such individual averages were identified, and the unit by unit averages from all of these units was averaged. This resulted in an overall average measured emissions performance level for units representative of the top 12 percent of units in the subcategory.

The second step in this part of the process involved generating and applying an appropriate variability factor to account for unavoidable variations in emissions due primarily to uncontrollable differences in fuel characteristics and ordinary operational variability. All the units for which we had emission test data using the same technology, or technologies, were identified as units in the top 12 percent. Then, for each such unit with multiple emission tests, the variability in the measured emissions was calculated from that unit by dividing the highest three-run test result by the lowest three-run test result. Finally, the overall variability in the measured emissions from these units was calculated by averaging all the individual unit variability factors. This overall variability factor was multiplied by the overall average measured emissions performance level (as described above) to derive a emission limit representative of the average emission limitation achieved by the top 12 percent of units.

This approach reasonably ensures that the emission limit selected as the MACT floor adequately represents the average level of control actually achieved by units in the top 12 percent, considering ordinary operational variability.

During the public comment period, commenters requested that EPA account for variability in fuel composition as MACT floors are established and to provide adequate allowances for inherent fuel supply variability. Commenters contended that EPA's calculation of variability was statistically unsound and recommended that EPA estimate statistically the variance in the distribution of control technology efficiency rather than calculate a variability

factor. Based on comments, we did conduct a statistical analysis of the data to identify the 95th and 99th percent confidence limits. This analysis provided similar results to the variability analysis approach conducted for the proposed rule. Consequently, we decided not to change the variability methodology.

Some boilers and process heaters within each subcategory may be able to meet the floor emission levels without using the air pollution control technology that is used by the top 12 percent of units in the subcategory. This is to be expected, given the variety of fuel types, fuel input rates, and boiler designs included within each subcategory and the resulting variability in emission rates. Thus, for instance, boilers or process heaters within the large unit solid fuel subcategory that burn lower percentages of solid fuels may be able to achieve the emission levels for the large unit solid fuel subcategory without the need for additional control devices.

Furthermore, solid fuels, especially coal, are very heterogeneous and can vary in composition by location. Coal analysis data obtained from the electric utility industry in another rulemaking contained information on the mercury, chlorine, and ash content of various coals. A preliminary review of this data indicate that the composition can vary greatly from location to location, and also within a particular location. Based on the range of variation of mercury, chlorine, and ash content in coal, it is possible for a unit with a lower performing control system to have emission levels lower than a unit considered to be included in the best performing 12 percent of the units.

This situation is reflected in the emissions information used to set the MACT floor emission limits. In some instances there are boilers with ESP or other controls that achieve similar, or lower, outlet emission levels of non-mercury metallic HAP, PM, or mercury than fabric filters. In most cases, this is due to concentrations entering these other control devices being lower, even though the percent reduction achieved is lower than fabric filters.

Additionally, the design of some control devices may have a substantial effect on the their emission reduction capability. For example, fabric filters are largely insensitive to the physical characteristics of the inlet gas stream. Thus, their design does not vary widely, and emissions reductions are expected to be similar (e.g. 99 percent reduction of PM). However, ESP design can vary significantly. Some ESP are 2 fields, others may have 3 or 4. The more fields the larger the emission reduction for PM. Similarly, other devices can be designed to

achieve higher emission reductions. This level of detail was not available for the information used to develop the MACT floor emission limits.

For existing unit subcategories where less than 12 percent of units in the subcategory use any type of control technology, the same approach could not be used to identify the average level of control achieved by the top 12 percent. Therefore, the central tendency of the best controlled units was estimated by looking at the median unit of the top 12 percent (the unit at the 94th percentile). If the median unit of the top 12 percent is using some control technology, the measured emission performance of that individual unit was used as the basis for estimating an appropriate average level of control of the top 12 percent. For subcategories where even the median unit is using no control technology, the average control of the top 12 percent of units is no emission reductions.

Large Solid Fuel Units - Heat Inputs Greater than 10 MMBtu/hr. As described earlier, a PM level is set as a surrogate for non-mercury metallic HAP, and fabric filters are the MACT floor control technology. Using the two-step methodology described in Section 8.2, the proportion of the units using fabric filters in the population database that were among the top 12 percent of units in the subcategory were identified and a corresponding proportion of the emission test data from units using fabric filters were reviewed, and an overall average measured performance level was calculated. Approximately 14 percent of the boilers in the population database used fabric filters. Including the emission data obtained during the public comment period, the emissions database contains PM information on 11 different boilers using fabric filters. (Emission data from one unit, Energy Products of Idaho, was removed from the analysis since this unit is used for research and development and, thus, is not in this subcategory.)   In order to rank the units using the best technology for which there were emission test data, unit by unit measured performance levels were calculated by averaging the multiple tests from each individual test (if multiple tests were available). The best 12/14 of the units in the emissions database were identified (i.e., the best 9 boilers). The average PM emission limit from the best 9 boilers is 0.015 lb/MMBtu, and the average variability level is 4.55. Incorporating the variability, the MACT floor emission level for PM is 0.07 lb/MMBtu. This analysis is shown in Appendix C-1.

An alternative metals limit was also calculated and can be used to show compliance in cases where metal HAP emissions are low in proportion to PM emissions.   This is because,

according to the emissions database, some biomass units have low metals content but high PM emissions. The available emission test data for solid fuel boilers with either an ESP or a fabric filter control were identified. These tests were further screened for only those tests that included emission results for all of the eight total selected metals (arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, and selenium) and corresponding PM results. The sum of the emissions of these eight metals, in terms of lb/MMBtu, were then ranked from highest to lowest emissions. Then, beginning with the highest tests, those tests that also included corresponding PM data were identified. For existing sources, the highest test results for metals having corresponding PM data available indicated a PM emission level of 0.0232 lb/MMBtu which is below the MACT floor PM emission level for existing solid fuel sources. Because this source is meeting the MACT floor PM emission level, the corresponding alternative metallic HAP emissions level for existing sources was set based on this source. However, since the corresponding PM emission limit (0.023lb/MMBtu) is well under the MACT floor PM emission level (0.7lb/MMBtu), the alternative total selected metals (TSM) MACT floor emissions level for existing sources was determined by extrapolating the TSM emission level from this source based on the difference in the PM emission levels. Therefore, the TSM MACT floor emission level is 0.001 lb/MMBtu [0.000416 x (0.07/0.023)]. This analysis is shown in Appendix C-2.

At proposal, the TSM MACT floor level for existing sources was determined to be 0.001 lb/MMBtu. However, this level did not incorporate variability. Based on comments, we reexamined our analysis for determining the TSM MACT floor level. First, it was determined that the metals test results from the unit selected, at proposal, as the basis had a questionable test run result for manganese that should not have been included in calculating the test results. (The high manganese concentration in one test run was attributable to transfer from the potassium manganese impingers.) Eliminating this test run resulted in a metals emission level of 0.000167 lb/MMBtu instead of 0.00084 lb/MMBtu. Thus, this unit is no longer the basis. The new basis is a unit with a metal level of 0.000416 lb/MMBtu and a corresponding PM level of 0.0232 lb/MMBtu. Since we have no multiple metals test results from any unit to determine variability and PM is a surrogate for metallic HAP, the appropriate approach was deemed to be the use of extrapolating based the difference between the source PM level and the MACT floor PM level. .

The MACT floor emission level for inorganic HAP is based on HCl emissions test information from units using wet or dry scrubbers or packed bed scrubbers. Approximately

13 percent of the boilers in the population database used scrubbers. The emissions database contains HCl information on 9 different boilers using scrubbers. In order to rank the units using the best technology for which there were emission test data, unit by unit measured performance levels were calculated by averaging the multiple tests from each individual test (if multiple tests were available). The best 12/13 of the units in the emissions database were identified (i.e., the best 8 boilers). The average HCl emission limit from the best 8 boilers is 0.00962 lb/MMBtu, and the average variability level is 9.08. Incorporating the variability, the MACT floor emission level for HCl is 0.09 lb/MMBtu. This analysis is shown in Appendix C-3.

The MACT floor emission level for mercury is based on emissions test information from units using fabric filters. Approximately 14 percent of the boilers in the population database used scrubbers. Including the mercury emission data obtained during ther public comment period, the emissions database contains mercury information on 10 different boilers using fabric filters. In order to rank the units using the best technology for which there were emission test data, unit by unit measured performance levels were calculated by averaging the multiple tests from each individual test (if multiple tests were available). The best 12/14 of the units in the emissions database were identified (i.e., the best 9 boilers). The average mercury emission limit from the best 9 boilers is 0.00000302 lb/MMBtu, and the average variability level is 2.98. Incorporating the variability, the MACT floor emission level for mercury is 0.000009 lb/MMBtu. This analysis is shown in Appendix C-4.

Some boilers and process heaters that use technologies other than those used as the basis of the MACT floor may be able to achieve the MACT floor emission levels. For example, emission test data show that many boilers with well designed and operated ESP can meet the MACT floor emission levels for nonmercury metallic HAP and PM, even though the floor emission level for these pollutants is based on units using a fabric filters (however, we would not expect that all units using ESP would be able to meet the emission limits in the proposed rule).

Small Solid Fuel Units - Heat Inputs Less than or Equal to 10 MMBtu/hr.

Because less than 6 percent of the units in this subcategory used control techniques that limit emissions from any of the pollutant groups, the MACT floor emission level for existing units for each of the pollutant categories in this subcategory is no emissions reductions.

Limited Use Solid Fuel Units - Capacity Utilizations Less than or Equal to 10 Percent.

A PM limit was established as a surrogate for non-mercury metallic HAP control, reflecting the emission test data from units using ESP and fabric filters that were representative of the top 12 percent of units in the subcategory.

The emissions test database did not contain test data for limited use boilers and process heaters. In order to develop emission levels for this subcategory, information from units in the large solid fuel subcategory was used. This was considered to be an appropriate methodology because although the units in this subcategory are different enough to warrant their own subcategory (i.e., different purposes and operation), emissions of the specific types of HAP for which limits are being proposed (nonmercury metals) are expected to be related more to the type of fuel burned and the type of control used, than to unit operation. Consequently, the emissions information from the large solid fuel subcategory that is most representative of the units in this subcategory was used to establish MACT floor levels for this subcategory because the fuels and controls are similar.

Appendix A-4 shows that of the top 12 percent of units in this subcategory, 5.8 percent use fabric filters and 6.2 percent use ESPs. In order to account for both controls, the emissions database was reviewed for information on fabric filters and ESPs from solid fuel fired units. The emissions database contains significantly more information on units with ESPS than units with fabric filters. Less than 5.8 percent of the units in the emissions database have fabric filters. Therefore, the analysis used all the information from fabric filters and the remaining information from 6.2 percent of the ESPs to calculate the MACT floor limit. The ESP information was first divided into units burning coal and those burning biomass. The population database indicates that the majority of boilers in this subcategory burn coal. However, more emissions information is available for units burning biomass. In order to reflect the population database, all the units burning coal were incorporated into the analysis. The remaining ESPs burning biomass were ranked from lowest to highest emissions and the units with the lowest emissions were included in analysis of MACT floor emission limits. The average emission limit from this population of units (i.e., units with fabric filters, units with ESPs firing coal, and lowest emitting units with ESPS firing biomass) was calculated to be 0.0273 lb/MMBtu, and the operational variability was calculated to be 8.11. The MACT floor emission level based on this test data, considering operational variability, is 0.21 lb PM/MMBtu. An alternative metals limit of 0.004 lb metals/MMBtu was also calculated so that sources could show compliance in cases where metal

HAP emissions are low in proportion to PM emissions. The emissions database indicates that some biomass units have low metals content but high PM emissions. The emission level for metals was selected from metals test data associated with PM emission tests that met the MACT floor PM emission level. The same methodology used to calculate the alternative metals limit for large solid units was used for limited use units. Appendix C-5 and C-6 presents the calculation of PM emission limits for this subcategory.

Because fewer than 6 percent of units used controls that would reduce emissions of organic HAP, inorganic HAP, and mercury, the median unit for these HAP grouping reflects no emission reductions. Therefore, the MACT floor for inorganic HAP, organic HAP and mercury in this subcategory is no emission reductions.

Existing Liquid Fuel Boilers and Process Heaters. Less than 6 percent of the units in each of the liquid subcategories used control techniques that would reduce nonmercury metallic HAP and PM, mercury, organic HAP, or acid gases, (such as HCl). Therefore, for each subcategory of liquid fueled boilers and process heaters, the MACT floor is no emission reductions for nonmercury metallic HAP, mercury, inorganic HAP, and organic HAP.

Existing Gaseous Fuel Boilers and Process Heaters. No existing units in the gaseous fuel-fired subcategories were using control technologies that achieve consistently lower emission rates than uncontrolled sources for any of the pollutant groups of interest. Therefore, the MACT floor for existing sources in this subcategory is no emissions reductions for nonmercury metallic HAP, mercury, inorganic HAP, and organic HAP.

8.2.2   New Source MACT Floor Emission Levels

For each pollutant type in each subcategory, the available emission test data from units using the best control technology was used to identify the single unit with the best average measured performance. An emission limit, based on the measured performance of this single unit was calculated by applying an appropriate variability factor to account for unavoidable variations in emissions due to uncontrollable variations in fuel characteristics and control device performance.

The approach use to calculate the MACT floors for new sources is somewhat different from the approach used to calculate the MACT floors for existing sources. While the MACT floors for existing units are intended to reflect the average performance achieved by a representative group of sources, the MACT floors for new units are meant to reflect the

"emission control that is achieved in practice" by the best controlled similar source. Thus, for existing units, the central tendency of a set of multiple units is the focus, while for new units, the level of control that is representative of that achieved by a single "best controlled" similar source is calculated. As with the analysis for existing sources the new unit analysis must account for variability. To accomplish this for new sources, for the fuel dependant HAP emissions, what the "best controlled" similar source can achieve in light of the inherent and unavoidable variations in the HAP content of the fuel that such unit might potentially use was necessary to be determined. For non-fuel dependent HAP emissions, on the other hand, the inherent variability of the control technology used by sources in the category was analyzed.

Thus, for new units, after identifying the best control technology for each pollutant group within each subcategory (based on the control technology rankings), the emissions data available for boilers and process heaters controlled by these technologies was examined to determine achievable emission levels for PM (as a surrogate for nonmercury metallic HAP), total selected nonmercury metallic HAP, mercury, HCl (as a surrogate for inorganic HAP), and CO (as a surrogate for organic HAP). First, the units using the best control technology for which we had emissions data were determined. Then, the emission data for any unit with multiple test results was average, and the units were ranked based on the unit by unit average measured emissions performance. Then, the unit with the best average measured emissions performance was identified. Finally, to estimate the emission control achievable by this unit, a variability factor was applied to the average measured emissions performance of the best unit. For fuel dependant HAP emissions (mercury and HCl), the variability factor was calculated by looking at data on HAP variability in coal, from an analysis of coal properties obtained through a utility-related information collection request. The fuel dependant variability factor was derived by dividing the highest observed HAP concentration by the lowest observed HAP concentration from the utility coal analysis. This was done because coal available to utilities and industrial boilers and process heaters are expected to be similar, and coal is the solid fuel that is routinely used in such units that has generally the greatest degree of HAP variability. Once the fuel dependant variability factors were calculated, they were applied to the average measured emissions performance of the unit with the best data to derive the MACT floor level of control. This approach reasonably estimates the best source's level of control, adjusted for unavoidable variation in fuel characteristics which have a direct impact on emissions.

For non-fuel dependant HAP emissions (PM), the appropriate variability factor was calculated in the same general manner as for existing units. A variability factor for each unit using the same control technology as the unit with the best emissions data was calculated, and then the overall variability in the measured emissions from units was determined using this technology by averaging all the individual unit variability factors. Finally, this overall variability factor was applied to the average measured emissions performance of the unit with the best emissions data.

For new unit subcategories where no units in the subcategory employed any type of control technology, data could not be identified to represent the level of control of the best controlled similar unit. Accordingly, the MACT floor level of control for such subcategories is no emission reductions.

Large Solid Fuel Units - Heat Inputs Greater than 10 MMBtu/hr. As described earlier, a PM level is set as a surrogate for non-mercury metallic HAP and the MACT floor level of control is a fabric filter. The best performing boiler in the emissions database with a fabric filter has an average emission limit of 0.0054. See Appendix C-1. Incorporating the average variability for all the units with fabric filters, 4.55, results in the MACT floor PM emission limit of 0.025 lb/MMBtu.

An alternative metals limit was also calculated and can be used to show compliance in cases where metals HAP emissions are low in proportion to PM emissions. This is because, according to the emissions database, some biomass units have low metals content but high PM emissions. The available emission test data for solid fuel boilers with a fabric filter control were identified. These tests were further screened for only those tests that included emission results for all of the eight total selected metals (arsenic, beryllium, cadmium, chromium, lead, manganese, nickel, and selenium) and corresponding PM levels. The sum of the emissions of these eight metals, in terms of lb/MMBtu, were then ranked from highest to lowest emissions. For new sources, the highest test results for metals from a fabric filter having corresponding PM data available indicated a PM emission level of 0.0025 lb/MMBtu which is below the new source MACT floor PM emission level. Because this source is meeting the MACT floor PM emission level, the corresponding alternative metallic HAP emissions level for new sources was set based on this source. Incorporating variability, the alternative metallic HAP emissions level for new sources is 0.0003 lb/MMBtu. See Appendix C-2. As discussed earlier, at proposal,

variability was not incorporated. Incorporating variability resulted in a revising the proposed metals limit (0.0001 lb/MMBtu) to 0.0003 lb/MMBtu.

Hydrogen chloride emissions are dependent on the quantity of chlorine in the fuel burned. To estimate the emission control achievable by this unit, a variability factor was applied to the average measured emissions performance of the best unit. The variability factor was calculated by looking at data on HAP variability in coal, from an analysis of coal properties obtained through a utility-related information collection request.[6] The fuel dependant variability factor was derived by dividing the highest observed HAP concentration by the lowest observed HAP concentration from the utility coal analysis. This was done because coal available to utilities and industrial boilers and process heaters are expected to be similar, and coal is the solid fuel that is routinely used in such units that has generally the greatest degree of HAP variability. Once the fuel dependant variability factors were calculated, they were applied to the highest test result of the unit with the lowest average emission level to derive the MACT floor level of control. This unit had two multiple test results. Using the highest of the two test results was deemed more appropriate than using the average of the two because a difference fuel mixture was combusted during the two tests. Fuel analysis information shows that chlorine content can vary from 20 ppm to 3620 ppm for solid fired units. A variability factory calculated by dividing the highest value by the lowest value results in a value of 181. See appendix C-7. The variability factor was multiplied by the highest test run average of the best performing unit, 0.0000996 lb/MMBtu (indicated in Appendix C-3), resulting a MACT floor HCl emission level of 0.02 lb/MMBtu.

Mercury emissions are dependent on the amount of mercury in the fuel burned. Similar to the HCl analysis, a variability factor for mercury was derived from the mercury content of coal. The fuel dependant variability factor was derived by dividing the highest observed HAP concentration by the lowest observed HAP concentration from the utility coal analysis. This was done because coal available to utilities and industrial boilers and process heaters are expected to be similar, and coal is the solid fuel that is routinely used in such units that has generally the greatest degree of HAP variability. Once the fuel dependant variability factors were calculated, they were applied to the average emission level from the "best-controlled similar unit" (lowest emitting) to derive the MACT floor level of control. Available fuel analysis information shows that mercury content of coal boilers varies from 0.0254 ppm to 0.3186 ppm. See Appendix C-7.

A variability factor calculated by dividing the highest value by the lowest results in a value of 12.54.   The best performing unit in the emissions database has a mercury emission level of 0.00000023 lb/MMBtu, as indicated in Appendix C-4. Incorporating the variability with the lowest emission level results in the MACT floor mercury emission level of 0.000003 lb mercury/MMBtu.

Small Solid Fuel Units - Heat Inputs Less than or Equal to 10 MMBtu/hr. The emissions database did not contain test data for boilers and process heaters less than 10 MMBtu/hr heat input. In order to develop emission levels for this subcategory, test data were data from units in the large solid subcategory were used. This is considered an appropriate methodology because although the units in this subcategory are different enough to warrant their own subcategory (i.e., different designs and emissions), emissions of the specific HAP for which limits are being proposed (HCl, mercury, PM and metals) are expected to be related more to the type of fuel burned and the type of control used than to the unit design. Consequently, emissions test data from units greater than 10 MMBtu/hr heat input were used to establish the MACT floor levels for this subcategory for HCl, PM, nonmercury metallic HAP (using PM as a surrogate), and mercury because the fuels and controls are similar.

Because the same emissions data for large units are used for the small subcategory, the MACT floor emission levels are also the same. The MACT floor emission levels based on emissions data from the unit representing the best controlled similar source, and incorporating operational variability, are 0.025 lb PM/MMBtu or 0.0003 lb selected nonmercury metals/MMBtu, 0.000003 lb mercury/MMBtu, and 0.02 lb HCl/MMBtu.

Limited Use Solid Fuel Units - Capacity Utilizations Less than or Equal to 10 Percent. The emissions test database did not contain test data for limited use boilers and process heaters. In order to develop emission levels for this subcategory, test data from units in the large solid fuel subcategory were used. This was considered to be an appropriate methodology because although the units in this subcategory are different enough to warrant their own subcategory (i.e., different purposes and operation), emissions of the specific types of HAP for which limits are being proposed (HCl, mercury, and metals) are expected to be related more to the type of fuel burned and the type of control used, than to unit operation. Consequently, emissions information from the large solid fuel subcategory could be used to establish MACT floor levels for this subcategory because the fuels and controls are similar.

Because the same emissions data are used for limited use and large units, the MACT floor emission levels are also the same. The MACT floor emission levels based on test data from unit representing the best controlled similar source, and incorporating operational variability, are 0.025 lb PM/MMBtu or 0.0003 lb metals/MMBtu, 0.000003 lb mercury/MMBtu, and 0.02 lb HCl/MMBtu.

Large Liquid Units - Heat Inputs Greater than 10 MMBtu/hr. As discussed earlier, a PM level is set as a surrogate for nonmercury metallic HAP. The emissions database did not contain test data for boilers and process heaters with ESP. In order to develop a PM emission level for this subcategory, test data from oil-fired utility boilers controlled with ESP were used. Although the units in this subcategory are generally smaller than utility boilers, emissions of the specific HAP for which limits are being proposed (PM as a surrogate for metals) are expected to be related more to the type of fuel burned and the type of control used than to the size of the unit. Consequently, emissions test data from oil-fired utility boilers could be used to establish the MACT floor levels for this subcategory for non-mercury metallic HAP (using PM as a surrogate) because the fuels and controls are similar.[7]

However, none of the utility boilers with ESP's conducted multiple tests. Consequently, a variability factor could not be calculated in the manner described for solid units. In order to incorporate variability and also incorporate the best performing ESP, the highest uncontrolled PM emission level (0.414 lb/MMBtu) reported was multiplied by the emission reduction achieve be the best performing ESP (92 percent reduction in PM). See Appendix D-1. The resulting emission limit, 0.03 lb/MMBtu was used as the MACT floor emission level for PM. Unlike for solid fuel subcategories, liquid fuels that are low in metals are not high in PM emissions. Therefore, an alternative metals standard for the liquid subcategories was not calculated.

There was no available emissions test data for HCl from liquid fuel-fired boilers. Therefore, the available fuel analysis chlorine data for residual oil and distillate oil was identified for the purpose of determining a hydrogen chloride emission limit for new sources in the liquid subcategory. There was one chlorine data point for distillate oil and six chlorine data points available for residual oil. The MACT floor emission limit calculations for HCl were done using the highest residual oil data point of 160 mg chlorine/L. See Appendix D-2. Assuming that all chlorine in the fuel would be emitted as HCl, the chlorine content value was converted to an uncontrolled emission factor of 0.009 lb HCl/MMBtu.

For new sources in the large liquid fuel subcategory, the emission limit is based on the performance of a packed scrubber which is assumed to achieve at least 95% reduction of hydrogen chloride (although some can achieve up to 99 percent reduction). Applying a 95% reduction to the calculated uncontrolled residual oil emission factor results in an HCl limit of 0.0005 lb/MMBtu.

Small Liquid Units - Heat Inputs Less than or Equal to 10 MMBtu/hr. The emissions test database did not contain test data for liquid fuel boilers and process heaters less than 10 MMBtu/hr heat input capacity. In order to develop emission levels for this subcategory, information from units in the large liquid fuel subcategory was used. Although the units in this subcategory are different enough to warrant their own subcategory (i.e., different designs and emissions), emissions of the specific types of HAP for which limits are being proposed (HCl and metals) are expected to be more related to the type of fuel burned and the type of control than to unit design. Consequently, emissions information from units greater than 10 MMBtu/hr heat input capacity could be used to establish MACT floor levels for this subcategory because the fuels and controls are similar. The MACT floor emission level based on PM test data from a liquid fuel unit with an ESP representing the best controlled similar unit, and incorporating operational variability, is 0.03 lb PM/MMBtu, i.e., the same as for large units because the same information is used. For new sources in the small liquid fuel subcategory, the same methodology described for large units was used. However, the emission limit is based on the performance of a wet scrubber which is assumed to achieve at least 90 percent reduction of hydrogen chloride. Applying a 90 percent reduction to the calculated uncontrolled residual oil emission factor results in an HCl limit of 0.0009 lb/MMBtu. The MACT floor for new sources in this subcategory is no emissions reductions for mercury or organic HAP.

Limited Use Liquid Units - Capacity Utilizations Less than or Equal to 10 Percent. The emissions test database did not contain test data for limited use liquid fuel boilers and process heaters. In order to develop emission levels for this subcategory, information from units in the large liquid fuel subcategory was used. Although the units in this subcategory are different enough to warrant their own subcategory (i.e., different purposes and operation), emissions of the specific HAP for which limits are being proposed (HCl and metals) are more related to the type of fuel burned and the type of control used than to unit operation. Consequently, emissions information from units greater than 10 MMBtu/hr heat input capacity could be used to establish

MACT floor levels for this subcategory because the fuels and controls are similar. The MACT floor emission level based on PM test data from a liquid fuel unit with an ESP representing the best controlled similar unit, and incorporating operational variability, is 0.03 lb PM/MMBtu, i.e., the same as for large units because the same data is used. For new sources in the limited use liquid fuel subcategory, the same methodology described for large units was used. However, the emission limit is based on the performance of a wet scrubber which is assumed to achieve at least 90 percent reduction of hydrogen chloride. Applying a 90 percent reduction to the calculated uncontrolled residual oil emission factor results in an HCl limit of 0.0009 lb/MMBtu.

Gaseous Fuel Units. No existing units were using control technologies that achieve consistently lower emission rates than uncontrolled sources for any of the pollutant groups of interest. Therefore, no limits were determined.

9.0   ANALYSIS FOR INCLUSION OF PROCESS HEATERS

The process heaters in the population database were reviewed to determine what types of add-on controls existed. Many of these units were either gaseous fuel-fired or they did not have control information available, both of which had no effect on the outcome of the MACT floor analysis. The few solid fuel-fired process heaters that did have control information used similar control devices to those represented in the boiler MACT floor analysis, so that combining these units into the overall MACT floor analysis had no effect on the results.

Also, there was very little emissions test data available for process heaters and even less available for process heaters with the MACT floor level of control. An analysis conducted for the ICCR process heaters workgroup indicates that available data show that boiler emissions are an adequate surrogate for heater data, and no significant differences were identified in heater and boiler emissions.[8] Therefore, the emissions data used from boilers to determine the MACT floor emission levels was assumed to be representative of process heater emissions.

10.0   DETERMINATION OF HEALTH-BASED ALTERNATIVE TSM LIMIT

In anticipation of the possibility of including in the final rule a health-based TSM compliance alternative, the available emission test data for solid fuel units that included emission results for all of the eight total selected metals (arsenic, beryllium, cadmium, chromium, lead,

manganese, nickel, and selenium) were reexamined based on removing manganese from the summation. The sum of the emissions of the remaining seven metals, in terms of lb/MMBtu, were then ranked from highest to lowest emissions. Then, beginning with the highest tests, those tests that also included corresponding PM data were identified. For existing sources, the highest test results (0.0003965 lb/MMBtu) for metals (without manganese) having corresponding PM data available indicated a PM emission level of 0.0232 lb/MMBtu. It is the same units that has the highest TSM test results with or without manganese included. Because this source is meeting the MACT floor PM emission level, the corresponding health-based TSM HAP emissions level for existing sources was set based also on this source. Again, since the corresponding PM emission limit (0.023lb/MMBtu) is well under the MACT floor PM emission level (0.7lb/MMBtu), the health-based alternative TSM MACT floor emissions level for existing sources was determined by extrapolating the TSM (excluding manganese) emission level from this source based on the difference in the PM emission levels. Therefore, the health-based TSM (excluding manganese) MACT floor emission level is 0.001 lb/MMBtu [0.000397 x (0.07/0.023)]. This analysis is shown in Appendix C-2.

Table 6-1. Summary of MACT Floor Control Technologies

Source	Subcategory	Non-mercury metallic HAP	Mercury	Inorganic HAP	Organic HAP
Existing	Solid Large	Fabric Filter	Fabric Filter	Scrubber	None
	Solid Small	None	None	None	None
	Solid Limited	ESP or Fabric Filter	None	None	None
	Liquid Large	None	None	None	None
	Liquid Small	None	None	None	None
	Liquid Limited	None	None	None	None
	Gas Large	None	None	None	None
	Gas Small	None	None	None	None
	Gas Limited	None	None	None	None
New	Solid Large	Fabric Filter	Fabric Filter	Packed Bed Scrubber	CO limit
	Solid Small	Fabric Filter	Fabric Filter	Wet Scrubber	None

Source	Subcategory	Non-mercury metallic HAP	Mercury	Inorganic HAP	Organic HAP
	Solid Limited	Fabric Filter	Fabric Filter	Wet Scrubber	CO limit
	Liquid Large	ESP	None	Packed Bed Scrubber	CO limit
	Liquid Small	ESP	None	Wet Scrubber	None
	Liquid Limited	ESP	None	Wet Scrubber	CO limit
	Gas Large	None	None	None	CO limit
	Gas Small	None	None	None	None
	Gas Limited	None	None	None	CO limit

Table 8-1. Summary of MACT Floor Emission Limits (lb/MMBtu)

Source	Subcategory	Non-mercury metallic HAP	Mercury	Inorganic HAP	Organic HAP
Existing	Solid Large	0.07 for PM 0.001 for metals	0.000009	0.09 for HCl	None
	Solid Small	None	None	None	None
	Solid Limited	0.21 for PM 0.004 for metals	None	None	None
	Liquid Large	None	None	None	None
	Liquid Small	None	None	None	None
	Liquid Limited	None	None	None	None
	Gas Large	None	None	None	None
	Gas Small	None	None	None	None
	Gas Limited	None	None	None	None
New	Solid Large	0.025 for PM 0.0003 for metals	0.000003	0.02 for HCl	400 ppm CO limit
	Solid Small	0.025 for PM 0.0003 for metals	0.000003	0.02 for HCl	None
	Solid Limited	0.025 for PM 0.0003 for metals	0.000003	0.02 for HCl	400 ppm CO limit
	Liquid Large	0.03 for PM	None	0.0005 for HCl	400 ppm CO limit
	Liquid Small	0.03 for PM	None	0.0009 for HCl	None
	Liquid Limited	0.03 for PM	None	0.0009 for HCl	400 ppm CO limit
	Gas Large	None	None	None	400 ppm CO limit
	Gas Small	None	None	None	None
	Gas Limited	None	None	None	400 ppm CO limit None

10.0   References

1.   Jeanette Alvis and Christy Burlew, ERG. Memorandum to Jim Eddinger, U.S. Environmental Protection Agency, OAQPS. *Development of the Population Database for the Industrial/Commercial/Institutional Boiler and Process Heaters National Emission Standards for Hazardous Air Pollutants*. October, 2002

2.   Jeanette Alvis and Christy Burlew, ERG. Memorandum to Jim Eddinger, U.S. Environmental Protection Agency, OAQPS. *Development of the Emissions Test Database for the Industrial/Commercial/Institutional Boiler and Process Heaters National Emission Standards for Hazardous Air Pollutants*. October, 2002.

3.   Roy Oommen, ERG. Memorandum to Jim Eddinger, U.S. Environmental Protection Agency, OAQPS. *Methodology for Estimating Cost and Emissions Impacts for Industrial, Commercial, Institutional Boilers and Process Heaters National Emission Standards for Hazardous Air Pollutants*. October, 2002.

4.   Chad Leatherwood, ERG. Memorandum to Jim Eddinger, U.S. Environmental Protection Agency, OAQPS. *Development of Fuel Switching Costs and Emission Reductions for Industrial/Commercial/Institutional Boilers and Process Heaters National Emission Standards for Hazardous Air Pollutants*. October 2002.

5.   Petroleum Environmental Research Forum. Project 92-19. The Origin and Fate of Toxic Combustion Byproducts in Refinery Heaters and Boilers.

6.   Coal mercury data. Working Group distribution materials on EPA website for the Utility MACT: "www.epa.gov/ttn/atw/combust/utiltox/utoxpg.html#DA2". January 2002.

7.   Working Group distribution materials on EPA website for the Utility MACT: "www.epa.gov/ttn/atw/combust/utiltox/utoxpg.html#DA2". January 2002.

8.   Jason Huckaby, Eastern Research Group. Memorandum to Bill Maxwell, U.S. Environmental Protection Agency. *Boiler and Heater Emissions Comparison*. November 6, 1998.

APPENDIX A

MACT Floor Control Technology Analysis Tables

(See Excel Spreadsheet "MACTfloorappA-D.xls")

APPENDIX B

Summary of CO Monitoring Information

(See Excel Spreadsheet "MACTfloorappA-D.xls")

APPENDIX C

Emission Limit Analysis Tables for Solid Subcategories

(See Excel Spreadsheet "MACTfloorappA-D.xls")

APPENDIX D

Emission Limit Analysis Tables for Liquid Subcategories

(See Excel Spreadsheet "MACTfloorappA-D.xls")